IMAGE PROCESSING
Chpt-①.

Introduction

- What is Digital Image Processing?

Digital Image
— a two-dimensional function $f(x, y)$
x and y are spatial coordinates
The amplitude of f is called **intensity** or **gray level** at the point (x, y)

Digital Image Processing
— process digital images by means of computer. It covers low-, mid-, and high-level processes
low-level: inputs and outputs are images → binarization
mid-level: outputs are attributes extracted from input images → segmentation
high-level: an ensemble of recognition of individual objects → scene understanding

Pixel
— the elements of a digital image

Figure 1.2, A digital picture made in 1922.

Photgraphic reproduction made from tapes perforated (a series of rows of small holes made in it) at telegraphic receiving terminal.

Observation: Both in quality and resolution, this figure is improved than the previous one.

Origins of Digital Image Processing

-The type of image that is obtained from 15 tone equipment.

- Coding images in five distant gray levels.

- Though these images involve digital images, these can not be considered image processing results.

Reason:
-In their creation, computers are not involved.

FIGURE 1.1 A digital picture produced in 1921 from a coded tape by a telegraph printer with special type faces. (McFarlane.†)

Sent by submarine cable between London and New York, the transportation time was reduced to less than three hours from more than a week

It's based on selection of printing procedure and distribution of intensity levels

Origins of Digital Image Processing

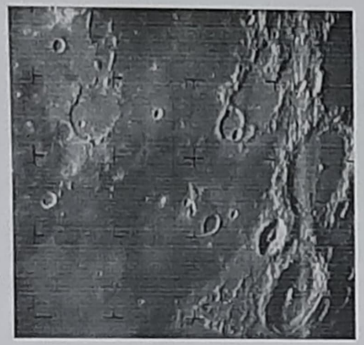

FIGURE 1.4 The first picture of the moon by a U.S. spacecraft. *Ranger 7* took this image on July 31, 1964 at 9:09 A.M. EDT, about 17 minutes before impacting the lunar surface. (Courtesy of NASA.)

DIP dependents on

- Data storage, display and transmission (supporting technologies) and development technologies.
- John von Neumann introduced DIP in 1940 based on a CPU; a memory to hold stored program and conditional branching.
- A series of key advancements were made to the technologies which make the computers powerful enough.

Sources for Images

- Electromagnetic (EM) energy spectrum
- Acoustic
- Ultrasonic
- Electronic
- Synthetic images produced by computer

- The Bell laboratories (1948)–invention of a transistor.
- Invention of
  - -high level programming languages—
    COBOL (1950s) and FORTRAN (1960s).
  - - integrated circuits at Texas Instruments (1958)
- Development of
  - - operating systems (1960s).
  - - microprocessor (cpu, memory and input & output devices) by Intel (1970s).
  - - personal computer by IBM (1980s).
  - - VLSI and ULSI (1980s).

Examples: Gama-Ray Imaging

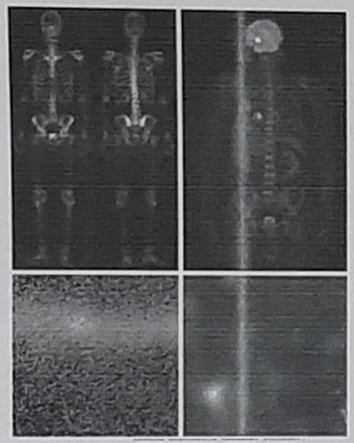

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FIGURE 1.6 Examples of gamma-ray imaging. (a) Bone scan. (b) PET image. (c) Cygnus Loop. (d) Gamma radiation (bright spot) from a reactor valve. (Images courtesy of (a) G.E. Medical Systems, (b) Dr. Michael E. Casey, CTI PET Systems, (c) NASA, (d) Professors Zhong He and David K. Wehe, University of Michigan.)

Electromagnetic (EM) energy spectrum

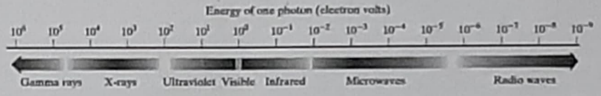


FIGURE 1.5 The electromagnetic spectrum arranged according to energy per photon.

Major uses

Gamma-ray imaging: nuclear medicine and astronomical observations

X-rays: medical diagnostics, industry, and astronomy, etc.

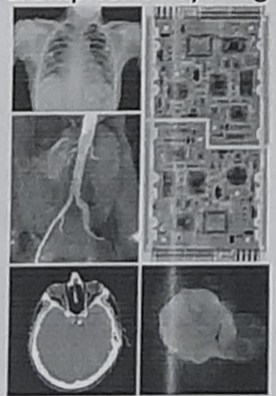
Ultraviolet: lithography, industrial inspection, microscopy, lasers, biological imaging, and astronomical observations

Visible and infrared bands: light microscopy, astronomy, remote sensing, industry, and law enforcement

Microwave band: radar

Radio band: medicine (such as MRI) and astronomy

Examples: X-Ray Imaging



a b
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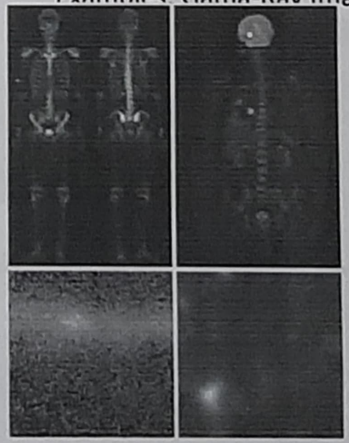
FIGURE 1.7 Examples of X-ray imaging. (a) Chest X-ray. (b) Aortic angiogram. (c) Head CT. (d) Circuit boards. (e) Cygnus Loop. (Images courtesy of (a) and (c) Dr. David R. Pickens, Dept. of Radiology & Radiological Sciences, Vanderbilt University Medical Center; (b) Dr. Thomas R. Gest, Division of Anatomical Sciences, University of Michigan

Examples: Gama-Ray Imaging



a b
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Examples: Visual and Infrared Imaging

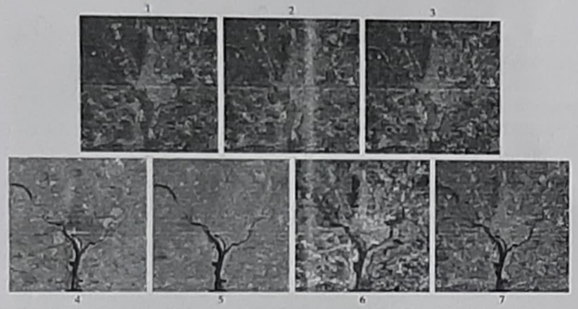

FIGURE 1.10 LANDSAT satellite images of the Washington, D.C. area. The numbers refer to the thematic bands in Table 1.1. (Images courtesy of NASA.)

Examples: Ultraviolet Imaging

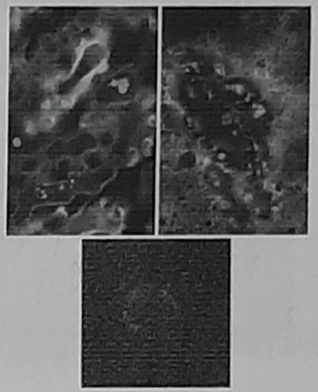

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FIGURE 1.8
Examples of ultraviolet imaging.
(a) Normal corn.
(b) Smut corn.
(c) Cygnus Loop.
(Images courtesy of (a) and (b) Dr. Michael W. Davidson, Florida State University, (c) NASA.)

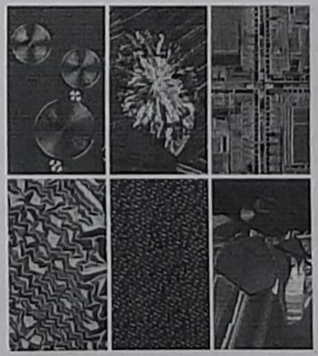
Examples: Visual and Infrared Imaging

TABLE 1.1
Thematic bands in NASA's LANDSAT satellite.

Band No.	Name	Wavelength (μm)	Characteristics and Uses
1	Visible blue	0.45–0.52	Maximum water penetration
2	Visible green	0.52–0.60	Good for measuring plant vigor
3	Visible red	0.63–0.69	Vegetation discrimination
4	Near infrared	0.76–0.90	Biomass and shoreline mapping
5	Middle infrared	1.55–1.75	Moisture content of soil and vegetation
6	Thermal infrared	10.4–12.5	Soil moisture; thermal mapping
7	~~Middle infrared~~	2.08–2.35	Mineral mapping

Short-wave infrared.

Examples: Light Microscopy Imaging



a b c
d e f

FIGURE 1.9 Examples of light microscopy images. (a) Taxol (anticancer agent), magnified 250×. (b) Cholesterol—40×. (c) Microprocessor—60×. (d) Nickel oxide thin film—600×. (e) Surface of audio CD—1750×. (f) Organic superconductor—450×. (Images courtesy of Dr. Michael W. Davidson, Florida State University.)

Examples: Automated Visual Inspection

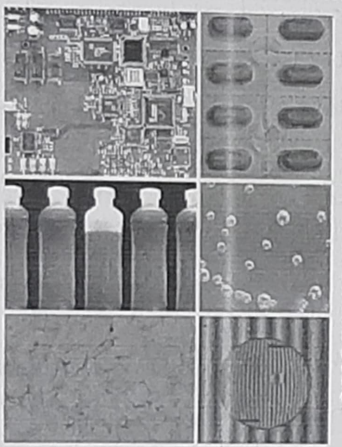


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FIGURE 1.14
Some examples of manufactured goods often checked using digital image processing. (a) A circuit board controller. (b) Packaged pills. (c) Bottles. (d) Air bubbles in a clear-plastic product. (e) Cereal. (f) Image of intraocular implant. (Fig. (f) courtesy of Mr. Pete Sites, Perceptics Corporation.)

Examples: Automated Visual Inspection

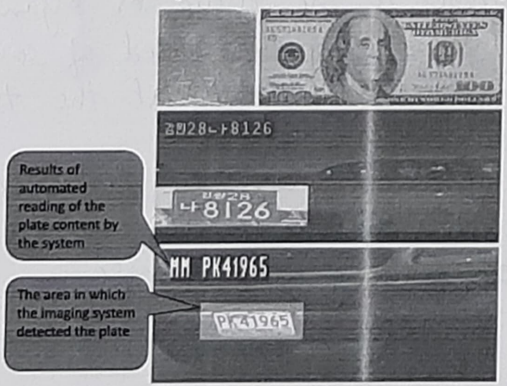

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FIGURE 1.15
Some additional examples of imaging in the visual spectrum. (a) Thumb print. (b) Paper currency. (c) and (d) Automated license plate reading. (Figure (a) courtesy of the National Institute of Standards and Technology. Figures (c) and (d) courtesy of Dr. Juan Herrera, Perceptics Corporation.)

Examples: Infrared Satellite Imaging